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VICTORY VALIDATION – AN INTRODUCTION AND TECHNICAL OVERVIEW

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ABSTRACT

For most standards bodies, the validation and maturation process is dependent on motivated members of the standards community to develop reference systems or components and to provide the governing body with the necessary data and details to support maturing a given specification or set of specifications. Although this has worked well for other standards bodies, the VICTORY Standards Support Office (VSSO) recognized early that validation would be key in rapidly defining usable specifications for the Army ground vehicle community. Understanding the importance of validating specifications, the VSSO formally defined a validation process that is used to aid in maturing the VICTORY Standard Specifications. This paper will focus on explaining the formalized validation process that is applied to the VICTORY Standard Specifications.

INTRODUCTION

Validation, for the Vehicular Integration for C4ISR/EW Interoperability (VICTORY) initiative, evaluates specifications generated by VICTORY working groups and implements reference functional components when applicable. Most standards bodies rely on their membership to provide validation support, which is an integral part of the VICTORY Standards development process. The VICTORY Standards Support Office (VSSO) formalized the validation process to enable rapid maturation of the VICTORY specifications. The validation process focuses on showing that 1) the specifications are complete and are not ambiguous 2) when implemented and integrated in a small scale system, the component and interface specifications results in the functional performance that was expected 3) the performance such as latency, network utilization, and general responsiveness is known and documented, 4) the development effort and the hardware required for an implementation of the components and interfaces used in the experiment are known and documented and 5) when implemented and integrated by independent entities, the resulting interoperability is known, documented, and is deemed acceptable.

Prior to delving into the intricacies of VICTORY Validation, it is necessary to gain a high-level understanding of the VICTORY process for the creation and validation of the specifications. Figure 1 is representative of this process.

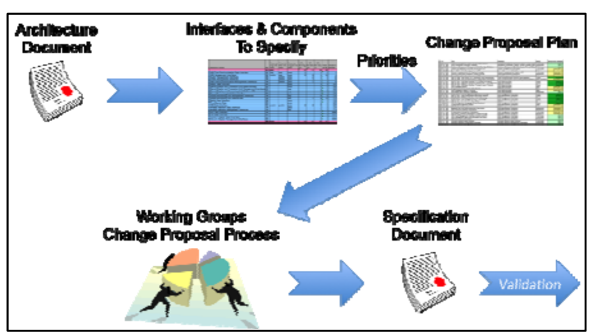

Figure 1: High-Level Specification Process

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14. ABSTRACT
For most standards bodies, the validation and maturation process is dependent on motivated members of the standards community to develop reference systems or components and to provide the governing body with the necessary data and details to support maturing a given specification or set of specifications. Although this has worked well for other standards bodies, the VICTORY Standards Support Office (VSSO) recognized early that validation would be key in rapidly defining usable specifications for the Army ground vehicle community. Understanding the importance of validating specifications, the VSSO formally defined a validation process that is used to aid in maturing the VICTORY Standard Specifications. This paper will focus on explaining the formalized validation process that is applied to the VICTORY Standard Specifications.

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The first step in creating a specification requires a working group to evaluate the VICTORY Architecture to determine which interfaces and components need to be specified and assign a specification priority to each. This priority dictates the order in which the topics will be presented to the working groups but does not guarantee the order in which a given specification will become available. With initiation from the members the leadership for a given working group devises an initial Change Proposal (CP) plan and presents it to the working group membership. Once the working group membership has agreed on the content, it will be documented and integrated into the VICTORY Standard Specifications with an experimental maturity level. Figure 2 below shows the maturity levels as defined by the VSSO and how they map to the types of validation mentioned previously.

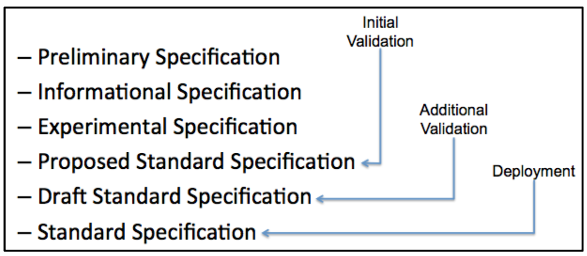

Figure 2: VICTORY Maturity Levels

Once an experimental specification has been documented, it will enter the validation process. The validation process has been formalized to produce more objective, reproducible and thorough experiment results and consists of two validation tracks as shown in Figure 3.

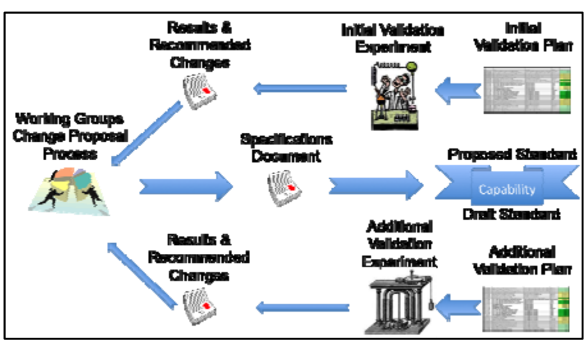

Figure 3: High-Level Validation Process

The first track is referred to as Initial Validation and it is responsible for performing experiments on the specifications that are at an experimental maturity level. This Initial Validation effort is led and funded by the VSSO. Initial Validation requires creating an experiment plan, performing the experiment, and reporting the results and recommendations back to the working group. After review, the working group makes the final recommendation to the VSSO to mature a specification to the proposed level. Once matured to the proposed level, the specification is inserted into the second validation track, referred to as Additional Validation. Additional Validation is performed by independent entities that do not fall within the VSSO footprint. It follows the same procedures as Initial Validation; however, Additional Validation experiments also include interoperability evaluations. Based on a review of the results and recommendations from the Additional Validation experiments, the working group decides if a specification is ready for the next maturation level. If so, the recommendation is made to the VSSO requesting that the specification become a Draft Standard Specification. The remainder of this paper will focus on describing the formalized process for both Initial and Additional Validation for the VICTORY Standard Specifications and will provide a brief status of what the validation process has accomplished thus far.

INITIAL VALIDATION

Initial Validation, is the first step in maturing the VICTORY Standard Specifications and provides the Army ground vehicle community with a sense of confidence that the specifications can be realized in fully functional components and are useable in real world systems. One might wonder how does initial validation provide this level of confidence to the community? Consider the artifacts from the initial validation experiments. For most specifications, the initial validation experiment requires a software reference implementation of the intended interfaces to be evaluated. Throughout the course of the initial validation effort, these reference components have been integrated into an extensive library of reference functional components that can be referred to during the development of production systems. The reference components show that an associated specification is usable, implementable, functionally correct, complete and non-ambiguous. Experiments, in many cases, document metrics about functional performance and resource requirements. This data can be valuable when one needs to know what the system performance for a given component is likely to be. The remainder of this section will outline the process for performing initial validation experiments and provide a brief status overview of the progress to date as well as what is planned for initial validation in the upcoming scheduled releases for the VICTORY Standard Specifications. The initial validation process requires high-level planning to

determine what specifications will be entering the initial validation track, developing initial validation experiment plans specific to the specifications being evaluated and conducting the experiment defined by the plan.

The high-level planning is the most crucial aspect of the initial validation track. It requires a mapping of projected capabilities to one or more change proposals (CPs) that each working group deems necessary to describe the specifications that will produce a capability. A VICTORY Capability is comprised of one or more specifications that have been matured to, at least, the “Proposed” level. The CP plan, developed by the working groups, provides a target date for defining an experimental level specification and is indicative of the earliest date that an experiment can start. In other words, the resulting dates provided in the Change Proposal plan determine when initial validation experiments will be scheduled in the Initial Validation plan.

Initial validation experiments are the thoroughfare for maturing the VICTORY Standard Specifications to the “Proposed” level. There are three main goals of initial validation: 1) ensure each specification is clear and complete; 2) develop reference functional components of each specification when applicable; and 3) mature the specifications to the “Proposed” level. There are two possible methods for performing initial validation experiments for the VICTORY Standard Specifications. One method is to perform entirely theoretical experiment and is commonly used when necessary hardware is unavailable or when a particular capability is readily available for a given specification (i.e. 3rd party software tools such as an Ethernet management interface for voice radios). During a theoretical experiment, VICTORY Standard Specifications will be scrutinized for clarity and completeness. Upon completion of the evaluation of the specifications, a detailed written analysis of all specified functionality will be performed. The second and the preferred method, shown in Figure 4, will be used to describe the typical process of an initial validation experiment.

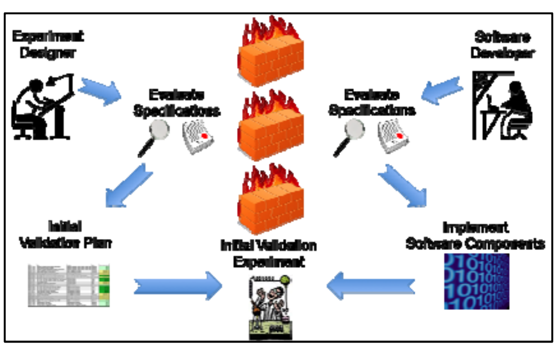

Figure 4: Initial Validation Experiment Process

The preferred method, for performing initial validation experiments, consists of multiple independent evaluations of the specifications. The evaluators for the experiment include an Experiment Designer and one or more Software Developers. An Experiment Designer evaluates the specifications with the focus being how to develop experiment procedures that will allow every aspect of the specification(s) to be evaluated through the use of a representative functional component. In parallel, the Software Developer evaluates the specification(s) with a focus on designing and implementing one or more representative functional components. During the evaluation of the specifications, the Experiment Designer and Software Developer perform their evaluations completely independent of one another and record any issues discovered. During this stage of an experiment, the two evaluators are separated by a “firewall” thereby allowing multiple independent evaluations to be achieved.

Upon completing the evaluation process, the Experiment Designer writes an initial validation experiment plan while the Software Developer designs and develops the representative functional component(s). The initial validation experiment plan states the goals of the experiment; serves as a record of specifications being evaluated; provides detailed procedures for evaluating the specifications; records any discrepancy found during the evaluation; and provides recommendations back to the working groups with regard to maturing the specifications and addressing any discrepancies. The representative functional components are used for evaluation purposes during the experiment procedures and will ultimately serve as reference implementations for the VICTORY community. Upon completion of the initial validation experiment plan and development of the representative functional components, the Experiment Designer and Software Developer(s) will combine their efforts to setup a representative experiment system and evaluate the procedures outlined in the experiment plan.

Validation Experiment Plan

An experiment plan outlines the procedures for conducting an initial validation experiment for a single specification or group of specifications. After a working group documents a given CP, an Experiment Plan can be designed. An Experiment Plan is designed to validate whether or not the specifications, documented by a Working Group, are un-ambiguous and whether there is enough content to enable the development of a representative functional component. In an effort to streamline designing the Experiment Plans, a template is used. This template provides an outline for how an experiment shall be

designed and provides uniformity across all initial validation experiments.

The procedure for designing an Experiment Plan consist of the following phases:

1. Review of the documentation provided by the working group. The documents consist of the specification document, schema, and Web Service Description Language (WSDL) files. During this phase, the content is scrutinized for ambiguities.
2. Develop experiment procedures for validating the documented specifications. The procedures target each specification being evaluated. Although they vary based on the specification being evaluated, it is common for them to evaluate latency, functional behavior, and bounds checking. In most instances, an experiment will require representative functional software components to be developed to evaluate the procedures and to show that the specifications can be implemented.
3. Create a logical and physical design for executing the experiment. This phase designs the hardware and software configurations necessary to perform the experiment.

Software Development

An integral part of initial validation, software development evaluates whether or not the VICTORY specifications can be transformed into a functional component. This portion of Initial Validation focuses on implementing a functional software component, or components, based on the specification document content, schema and WSDLs. To streamline the software development process for validation experiments, a software framework has been developed and is composed of common software component libraries that have been developed in prior validation experiments. For each validation experiment conducted, all software components or libraries deemed reusable are added to the software framework used for validation experiments.

The phases for developing initial validation software components are as follows:

1. Review the specification document, schema and WSDLs to determine the functionality that a software component shall provide. During this review, the schema and WSDLs are evaluated for ambiguities and crosschecked with the specification document to ensure consistency.
2. Develop a Software Design. During the design process for the software, the designer determines which software components are necessary to implement a functional component based on the review of the specification document, schema, and WSDLs. It is also determined if existing libraries from previous experiments can be used to streamline the development process. In most cases, there are a number of libraries that will be reused to perform routine functions that will not have an affect on results of an experiment.
3. Develop Software Components. During this phase, the software development team will develop the software components as outlined by the software design.

Performing Experiments

After developing the experiment plan and reference component implementations, the VICTORY Initial Validation Facility (VIVF) is configured in accordance with the logical and physical designs outlined in the experiment plan. The software components used typically consist of open source applications and those developed in accordance with the specifications being evaluated. When performing an experiment, the evaluator documents all discovered ambiguities, inconsistencies and flaws that may arise. These items are referred to as findings. The experiment plan contains a section to record the results of the experiment, all findings that have been uncovered, and recommendations for resolving the findings. Recommendations for maturing the specifications that have been evaluated are also documented in the experiment plan. All results, findings and recommendations are reported back to the working groups in the form of a CP. The CP is used to allow the working groups to determine how the specifications are affected as a result of the experiment.

Depending on the actions taken by the working groups, the experiment plan and supporting software may need to be revised. In cases where the supporting software cannot be developed in accordance with a documented specification, the initial validation experiment team will make a recommendation for how the specification could be documented and proceed with implementation based on that recommendation. If a working group decides to reject a recommendation and seek alternative solutions for a specification, the experiment plan and supporting software will need to be revised and the experiment will need to be performed again. In extreme cases, an entirely new experiment may be required.

Initial Validation Status

Table 1 shows how many experiments were completed and the number of proposed standards for each version of the VICTORY Standard Specifications that have been released.

Specification Version	Number of Experiments	Number of Proposed Specifications
1.0	20	108
1.1	14	35
1.2	16	37
TOTAL	50	180

Table 1: Initial Validation Progress

Table 2 shows how many experiments are planned and the approximate number of proposed standards that will be achieved as a result of the 1.3 and 1.4 releases of the VICTORY Standard Specifications. It should be noted that the data in Table 1 and Table 2 was based on data that was current when this paper was written. Since writing this paper, version 1.3 of the VICTORY Standards Specification has been released.

Specification Version	Number of Experiments	Number of Proposed Specifications
1.3	~12	~20
1.4	~18	~40
TOTAL	~30	~60

Table 2: Initial Validation Plans

INDEPENDENT DEVLOPMENT AND VALIDATION

US Army Tank Automotive Research, Development and Engineering Center (TARDEC) – Vehicle Electronics and Architecture (VEA) group developed an independent implementation [3] of VICTORY Architecture and Services at their VICTORY SIL with the purpose of maturing and standardizing ground vehicle electronic architecture, sub-system interfaces and compliance testing. An additional set of experiments were performed at the SIL to provide verification and validation of the VICTORY 1.0 Architecture core services and data bus standards. The testing implied that when implemented correctly with the standards format specified by the VICTORY 1.0 will provide VICTORY services data to the VDB (Victory Data Bus) as shown in Figure 5.

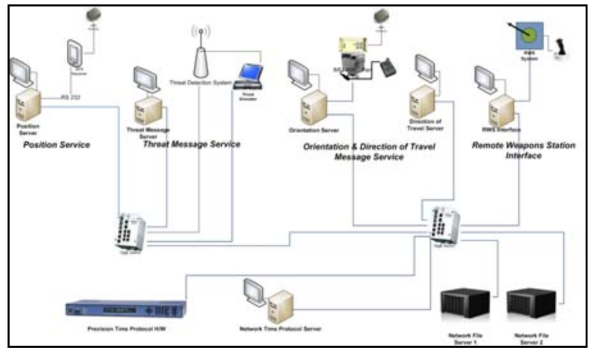

Figure 5: VICTORY Services network as implemented in the VICTORY SIL

The experiments conducted evaluated the interface specifications by integrating software clients and services developed using the specifications, and evaluating the resulting functional behavior and performance. The TARDEC Vehicle Electronics and Architecture (VEA) group executed this set of additional validation experiments, utilizing their VICTORY System Integration Laboratory (SIL).

Additional Validation Process

The test plans and the experiments performed are similar to those of the VIVF, the results and any additional findings are recorded in a series of test reports.

Additionally two test tools were used for managing and monitoring the VDM's:

a) Wireshark VDB plug-in

A custom dissector plug-in for Wireshark version 1.2.8 is developed for the VICTORY SIL and is used as a tool for testing and monitoring VDM's. This dissector captures UDP VICTORY Data Messages (VDMs) and breaks them down into their specific header and data fields. It also provides a filter to look for VDM messages and the ability to log captured VDMs to a formatted text file.

b) Terminal & GUI Client's for DoT & Orientation VDM Management

Two clients were developed to manage the VDM's: One is a command line client and the other is a GUI based client as shown in Figure 6. Both of these clients perform the same VDM control functionality, i.e. to enable/disable, set data rates, set update period, etc.

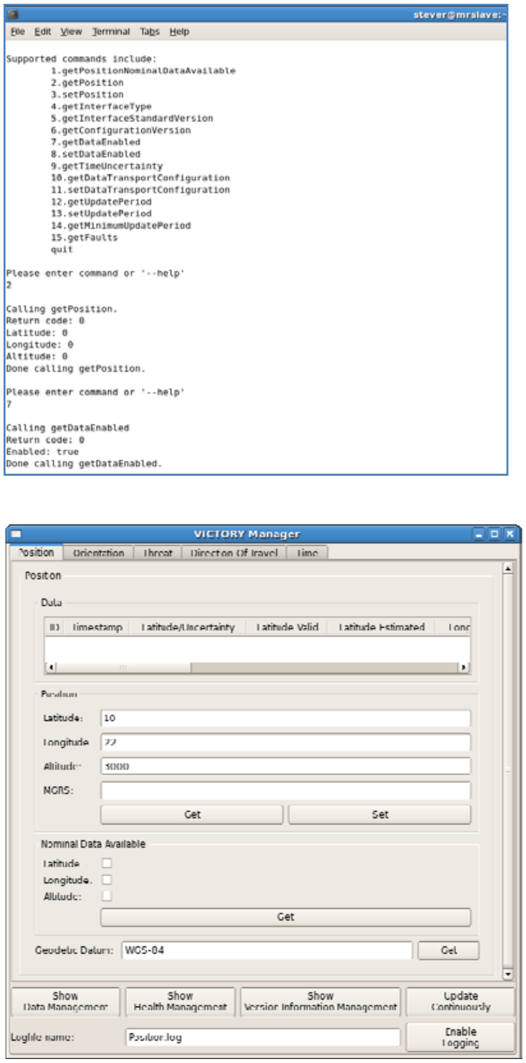

Figure 6: Terminal and GUI Client for VDM Management

Additional Validation Status

The Table 3 below shows the number of planned to completed experiments at 47% towards verification of the 1.0 standards. All the testing is performed at the TARDEC VICTORY SIL. As the TARDEC VICTORY SIL adapts other versions of the VICTORY standard specification, additional validation experiments will be planned and completed.

Specification Version	Number of Proposed Specifications Tested and Verified	Number of Proposed Specifications
1.0	45	96
TOTAL	45	96

Table 3: Additional Validation Progress

REFEENCES

[1] “Standards Development and Maturation Plan for VICTORY – Version 1.0”, April 23, 2010.

[2] “Validation Plan for the VEHICULAR INTEGRATION FOR C4ISR/EW INTEROPERABILITY (VICTORY) INITIATIVE – Version 1.0.1”, June 04, 2012.

[3] “TARDEC’s VICTORY Systems Integration Laboratory (SIL) is a Key Tool for Advancing Standardized Ground Vehicle Electronic Architecture” – Williams et.al. GVSETS, August, 2012